

Analysis of Homolog Distributions to Better Understand Nature of Loads

SRRTTF Data Synthesis
Workshop

May 30, 2019

Objective

- Compare homolog patterns to gain understanding of the nature of the load
 - Source mechanisms
 - Atmospheric deposition, Lake Coeur d'Alene
 - In-river response
- Won't provide definitive answers, but will provide data for “weight of evidence” approach

Example Outcomes

- If homolog patterns vary seasonally at a given location
 - Would lend support to the theory that loads vary seasonally
- If homolog patterns in atmospheric deposition are different than those in Lake Coeur d'Alene
 - Would lend support to the theory something other than atmospheric deposition is driving PCBs in the lake

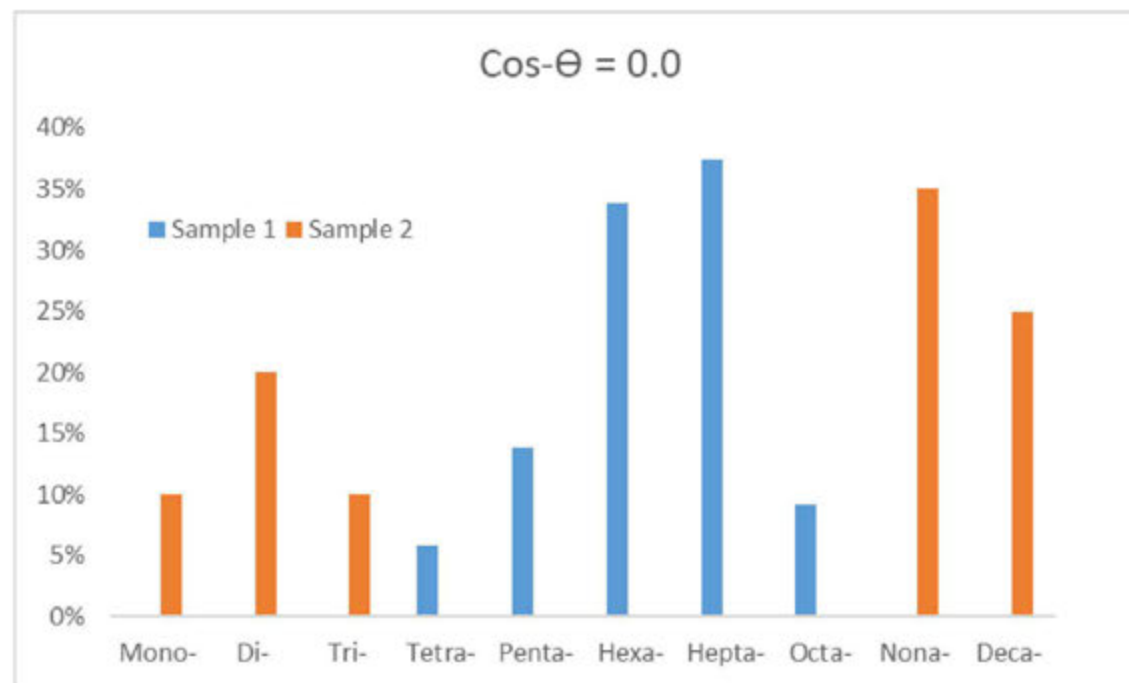
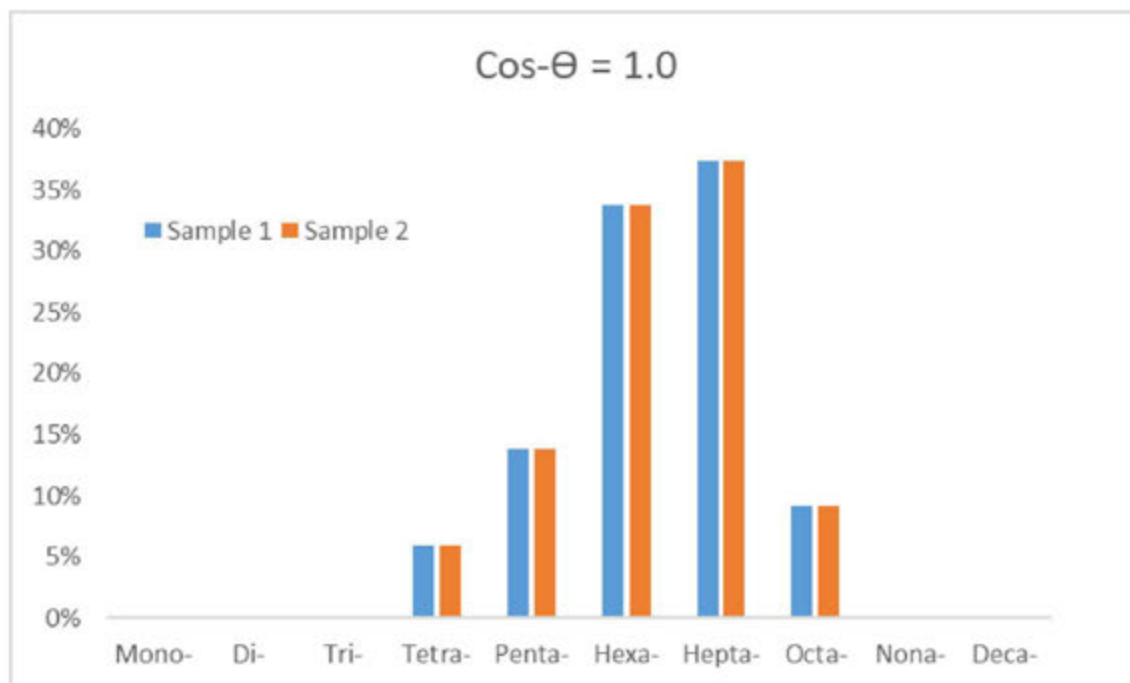
Measuring Similarity

- Calculated using cosine theta ($\cos\theta$) method
 - Quantitative method for assessing similarity between matrices (e.g. homolog patterns)
- Theory
 - Given two vectors of attributes, A and B, the cosine similarity is represented as:

$$\text{similarity} = \cos(\theta) = \frac{\mathbf{A} \cdot \mathbf{B}}{\|\mathbf{A}\| \|\mathbf{B}\|} = \frac{\sum_{i=1}^n A_i B_i}{\sqrt{\sum_{i=1}^n A_i^2} \sqrt{\sum_{i=1}^n B_i^2}},$$

Measuring Similarity

- $\cos-\theta$ is analogous to a correlation coefficient
 - Exact comparison, $\cos-\theta = 1$
 - Completely different patterns, $\cos-\theta = 0$



Similarity Analyses Conducted

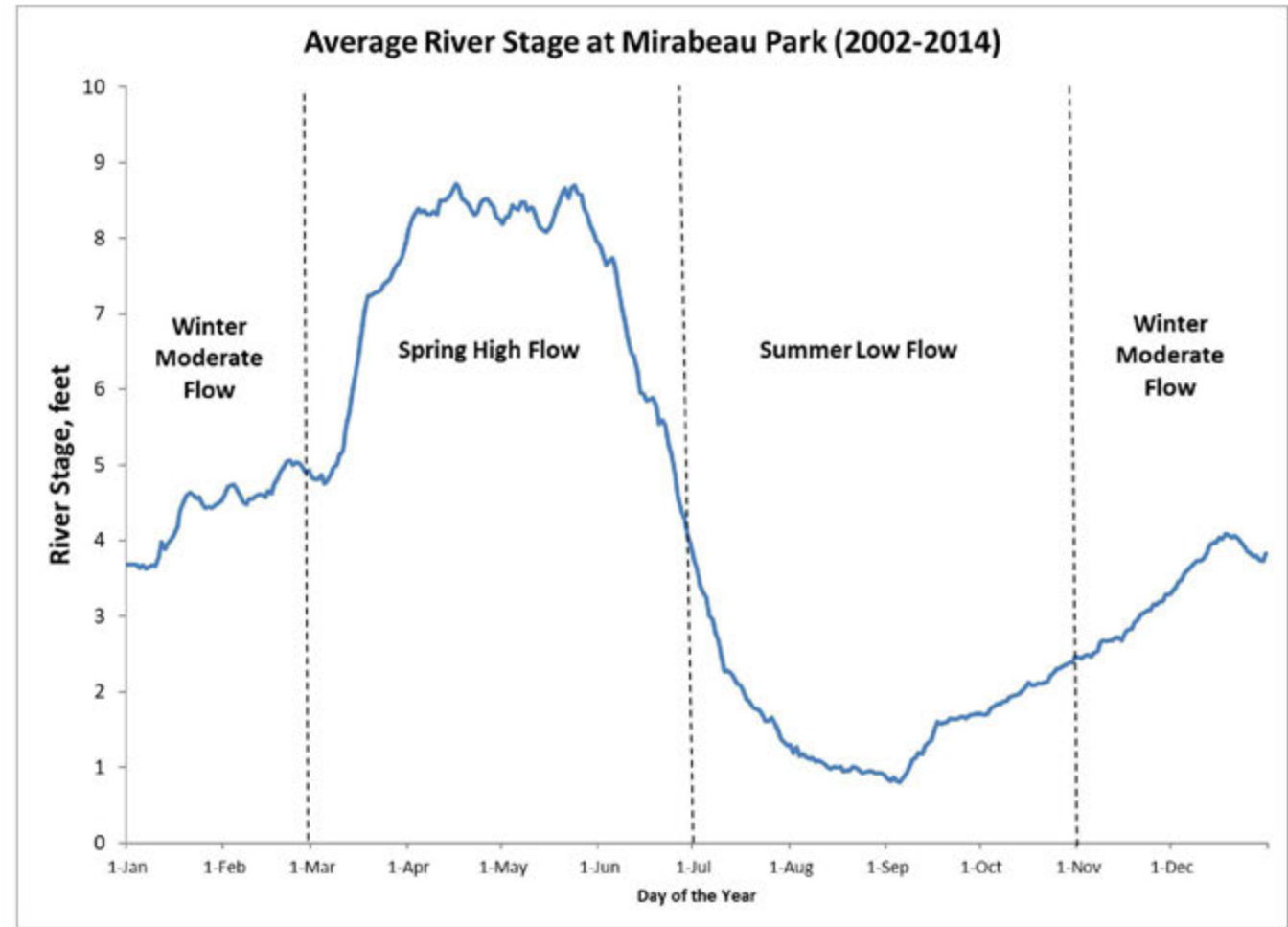
- Lake Coeur d'Alene seasonality
 - Does the nature of the load entering the river from Lake CdA vary seasonally?
- Atmospheric deposition
 - How do deposition patterns compare to patterns in delivery mechanisms?
- In-river seasonality
 - Does the nature of concentrations in the river vary seasonally?

Lake Coeur d'Alene Seasonality

- Assess seasonal variability of homolog distributions entering the river from Lake Coeur d'Alene
 - Different patterns by season may imply seasonally-varying loading sources

Lake CdA Seasonality: Approach

- Calculate similarity of homolog distributions for three different seasonal periods
 - Spring high flow
 - Summer low flow
 - Winter moderate flow



Lake CdA Seasonality: Available Data

- 2014 Confidence testing
 - 9 samples May 23, 2014
- 2014 Synoptic survey
 - 7 samples August 12-23, 2014
- 2016 Monthly monitoring
 - One sample each in March, April, May, October, November, December*

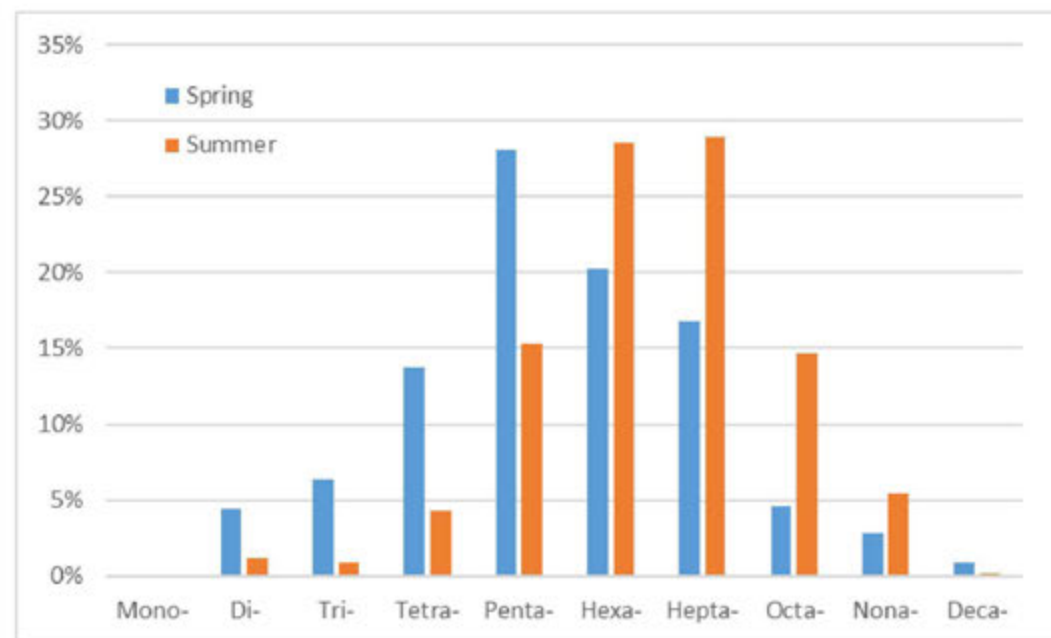
*excluded due to blank contamination

Lake CdA Seasonality: Results

- Cos- θ correlations by season

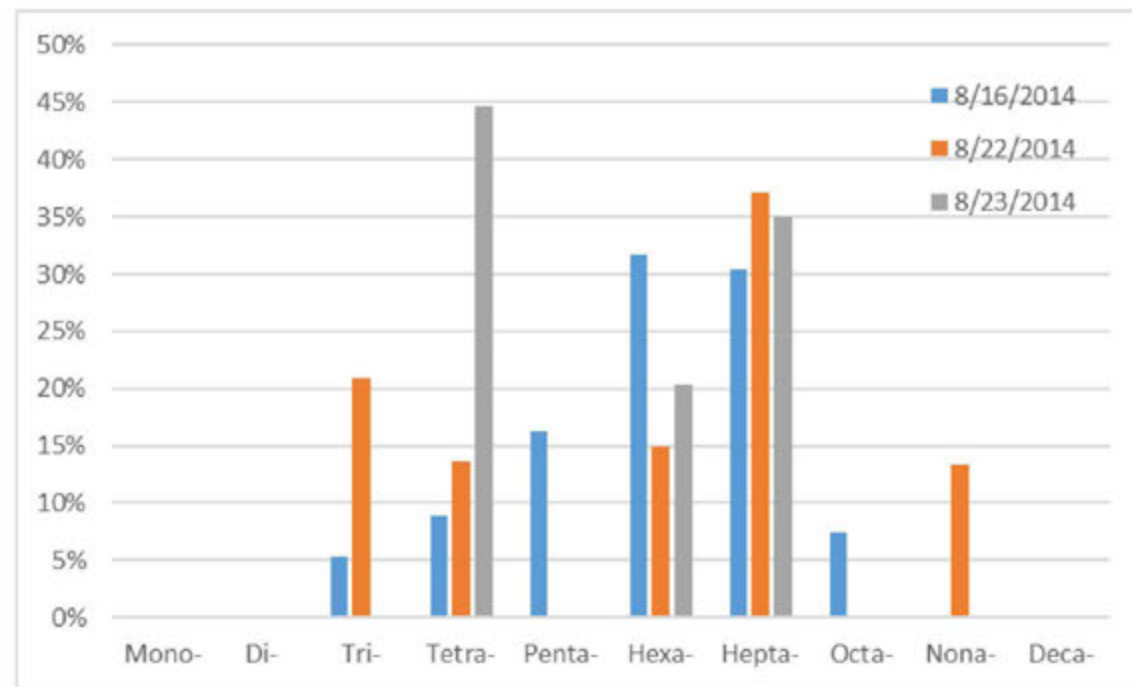
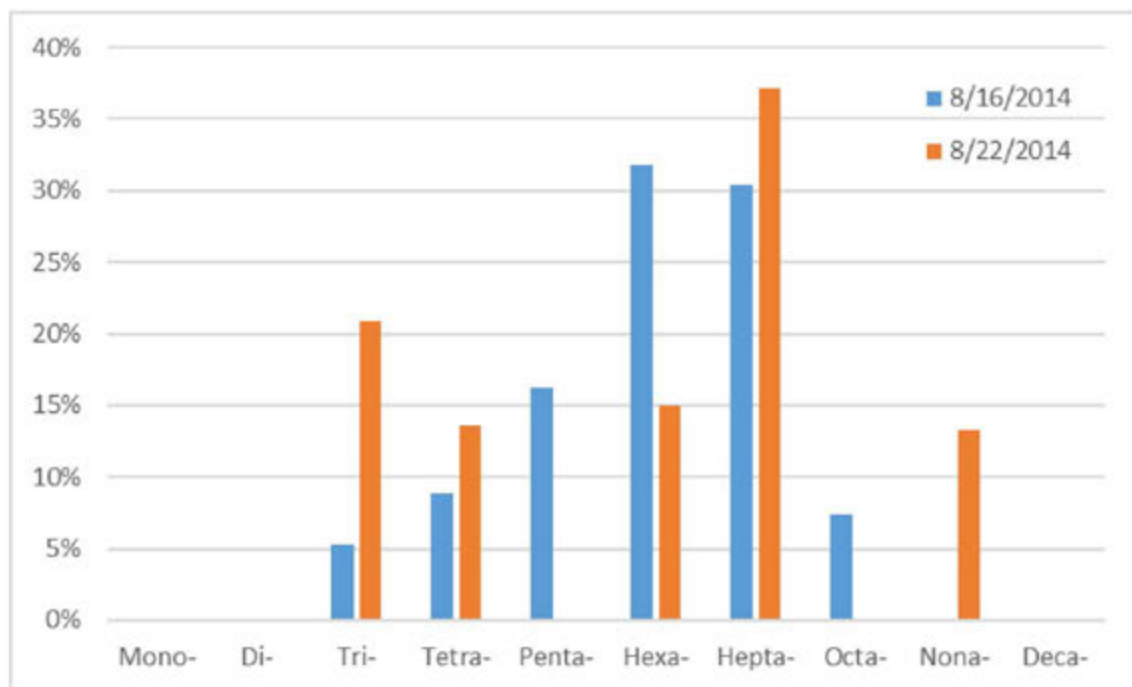
	Spring	Summer	Winter
Spring	1.00		
Summer	0.85	1.00	
Winter	*	*	*

*Only sample available from winter season had excessive blank contamination



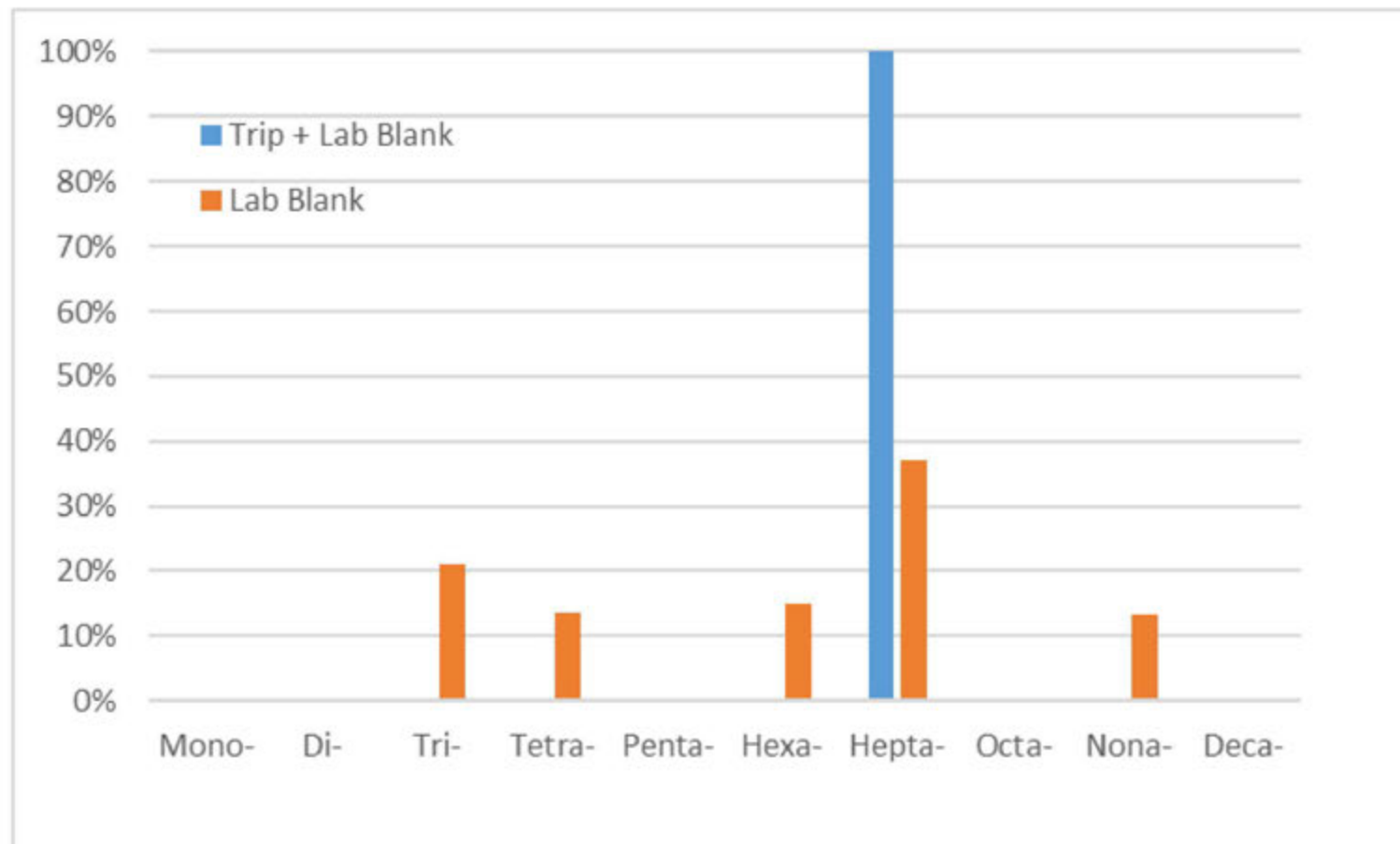
Lake CdA Data Usability

- High variability in patterns among samples in a given season
 - $\text{Cos-}\Theta=0.69$ among samples within a season



Lake CdA Data Usability

- High variability in patterns depending on blank correction method used



Lake CdA Seasonality: Conclusions

- We can't say anything with reasonable certainty about seasonality of Lake CdA homolog patterns
- Did we learn anything?
 - There is a limit to what we can say about patterns when ambient concentrations are that low
 - We could potentially glean more information using a less severe blank correction method
- Will additional monitoring help?
 - Not likely, until analytical methods improve

Similarity Analyses Conducted

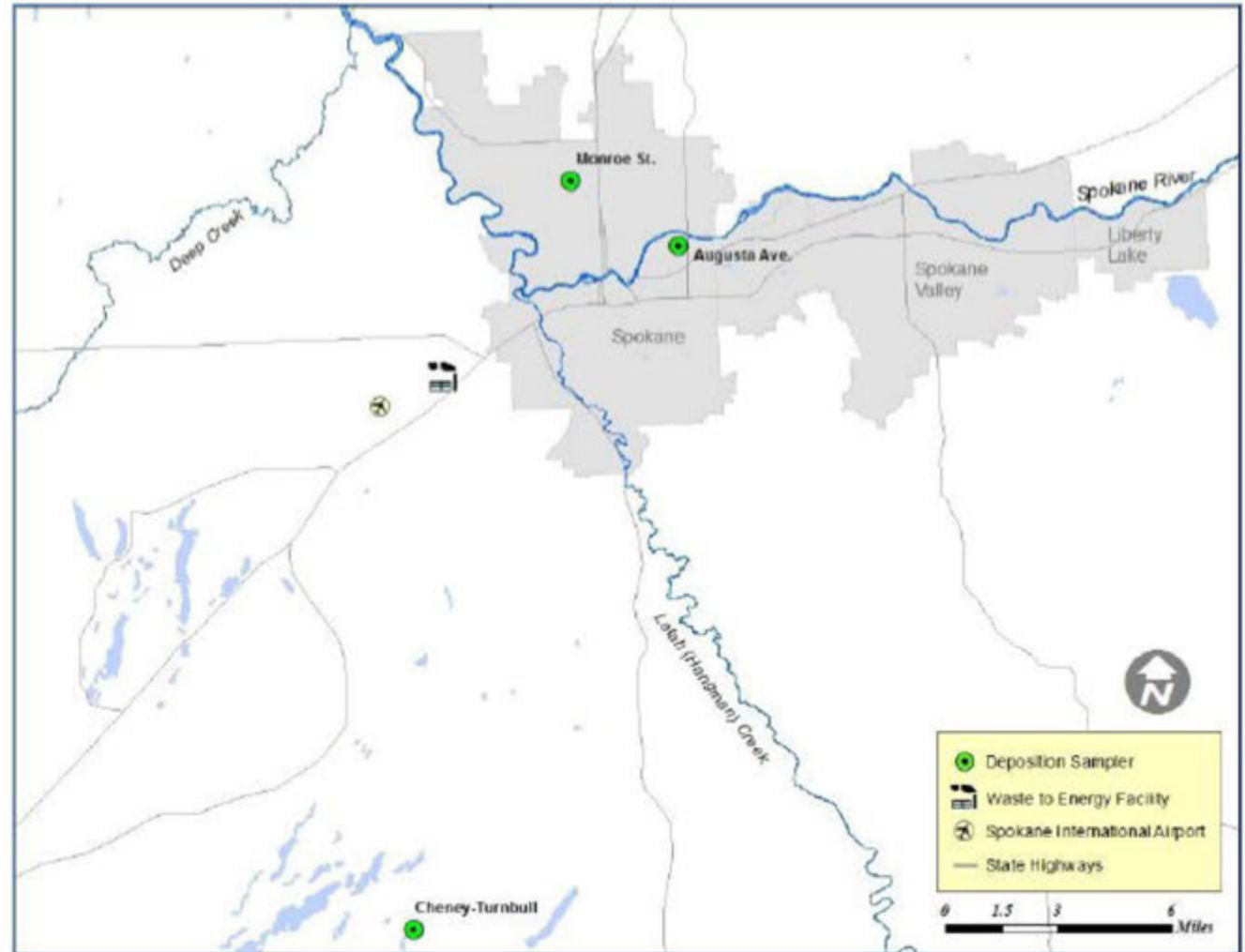
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Atmospheric Deposition Correlations

- How do homolog patterns in atmospheric deposition compare to patterns in delivery mechanisms?
- Deposition
 - 2014 EAP atmospheric deposition study
- Delivery mechanisms
 - Groundwater up-gradient of Kaiser
 - City of Spokane stormwater
 - Lake Coeur d'Alene

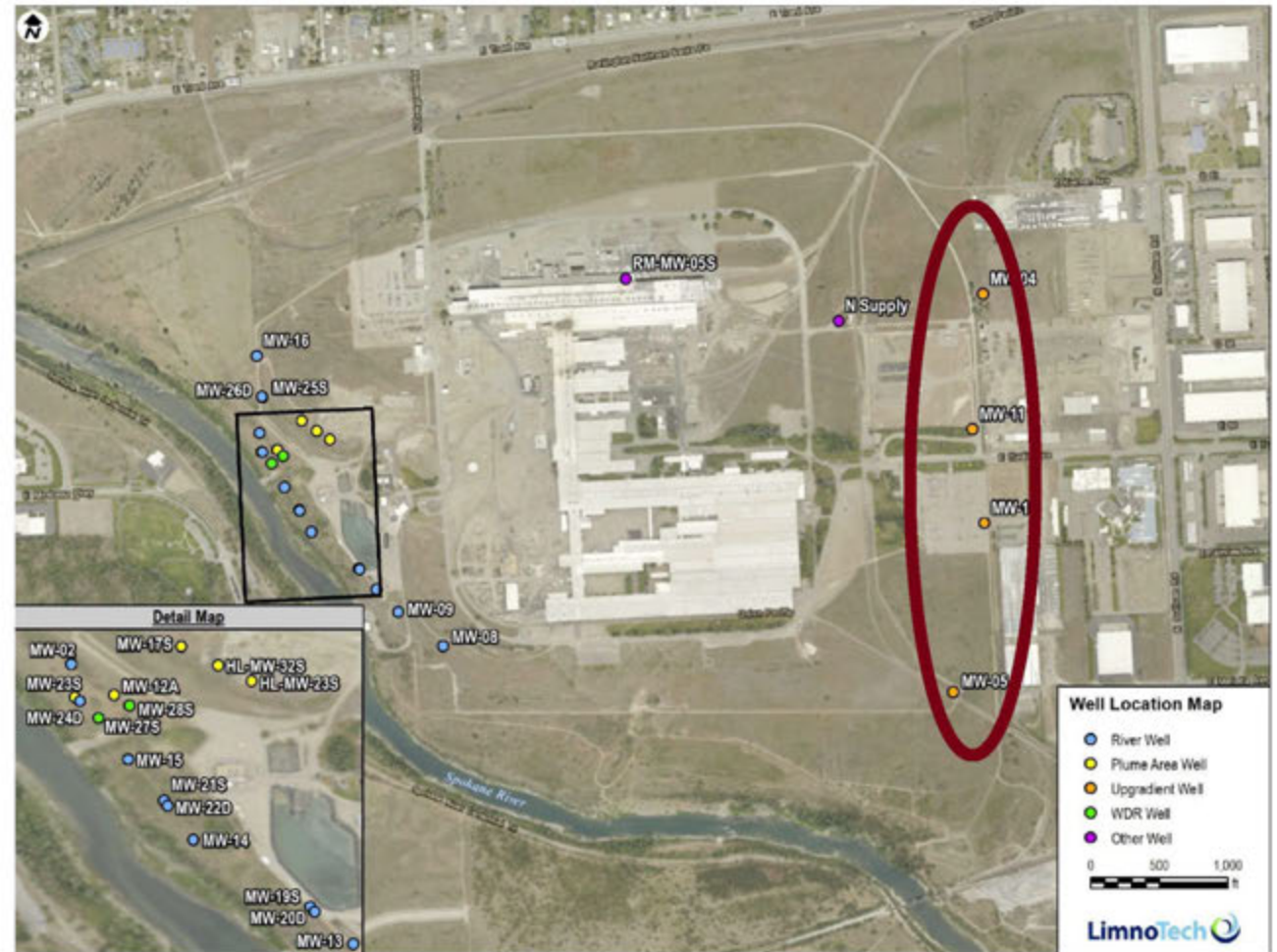
Atmospheric Deposition: Available Data

- Four quarterly samples over 2016-2017
- Three sites
 - Augusta: urban-commercial
 - Monroe: urban-residential
 - Turnbull NWR: background
- Pilot study
 - Variability in field replicates



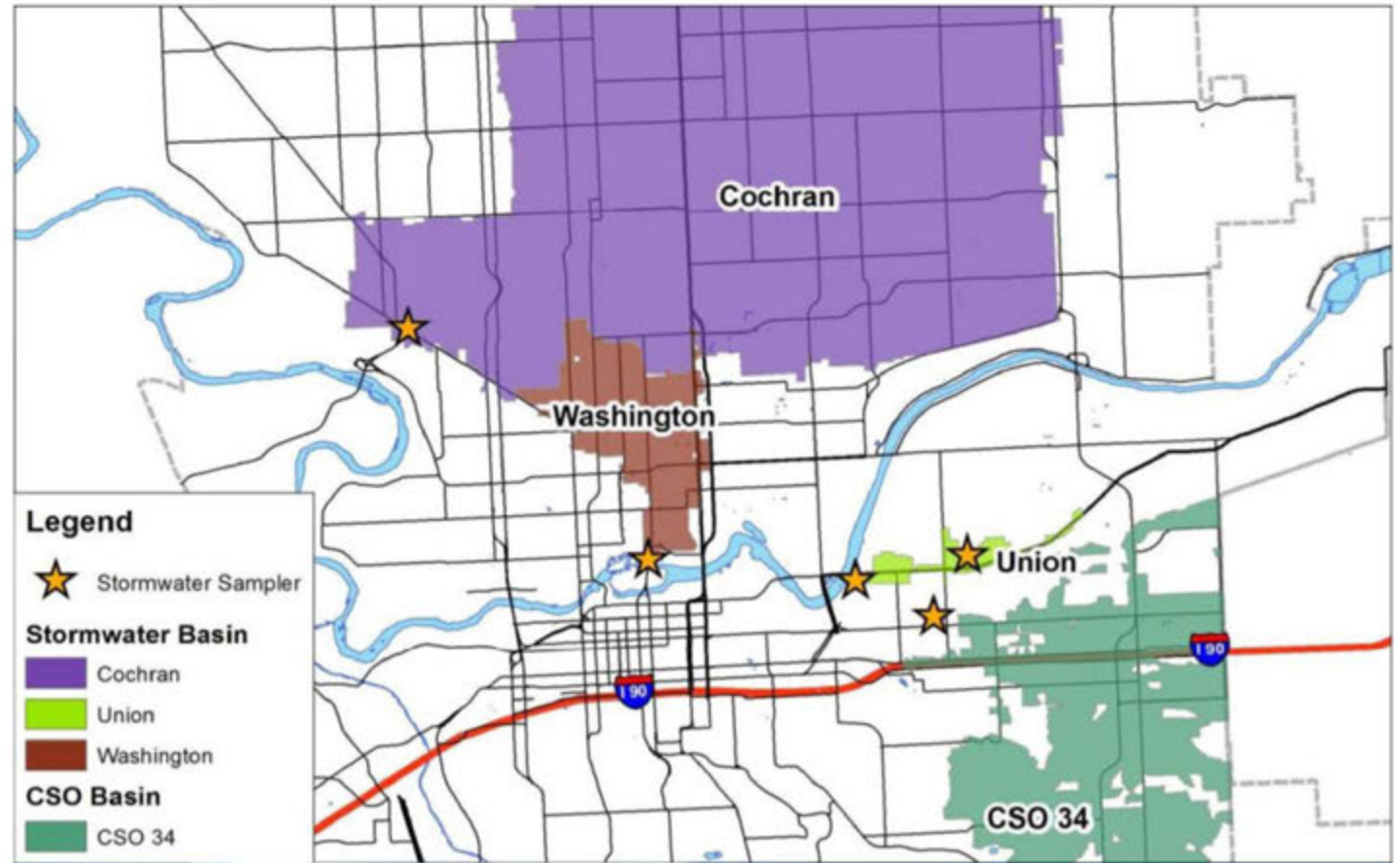
Atmospheric Deposition: Groundwater Data

- 77 samples from four wells up-gradient of Kaiser



Atmospheric Deposition: Stormwater Data

- Six samples from Cochran basin for four quarterly monitoring events in 2016-2017



Atmospheric Deposition Correlation Results

	Cos- θ		
	Augusta	Monroe	Turnbull
Lake CdA	*	*	*
Up-gradient Groundwater	0.93	0.72	0.51
Stormwater	0.91	0.66	0.38

- Lake Coeur d'Alene excluded due to low concentrations
- Monroe and Turnbull sites do not match either stormwater or up-gradient groundwater
- Better correlation with Augusta site

Atmospheric Deposition: Conclusions

- Ecology atmospheric deposition study was a pilot project, so available data should be used cautiously
- Poor correlation exists between deposition patterns at Monroe/ Turnbull sites and delivery mechanisms
- Will more data help?
 - Yes, but probably best left to Ecology
 - Too complex a topic for the Task Force to lead

Similarity Analyses Conducted

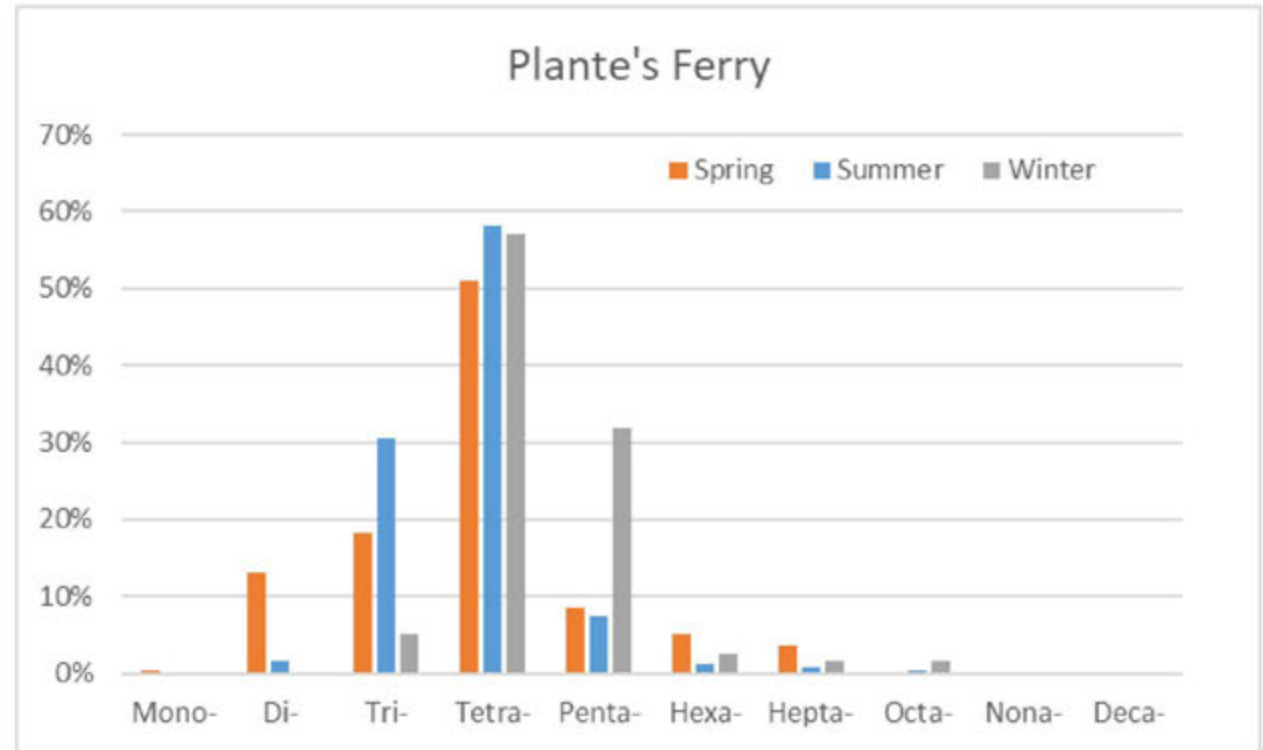
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In-River Seasonality: Data Considered

- Focus on stations sampled for all synoptic surveys, plus monthly
 - Plante's Ferry
 - 3 Spring samples
 - 15 Summer samples
 - 1 winter sample
 - Spokane USGS gage
 - 5 Spring samples
 - 14 Summer samples
 - 1 winter sample

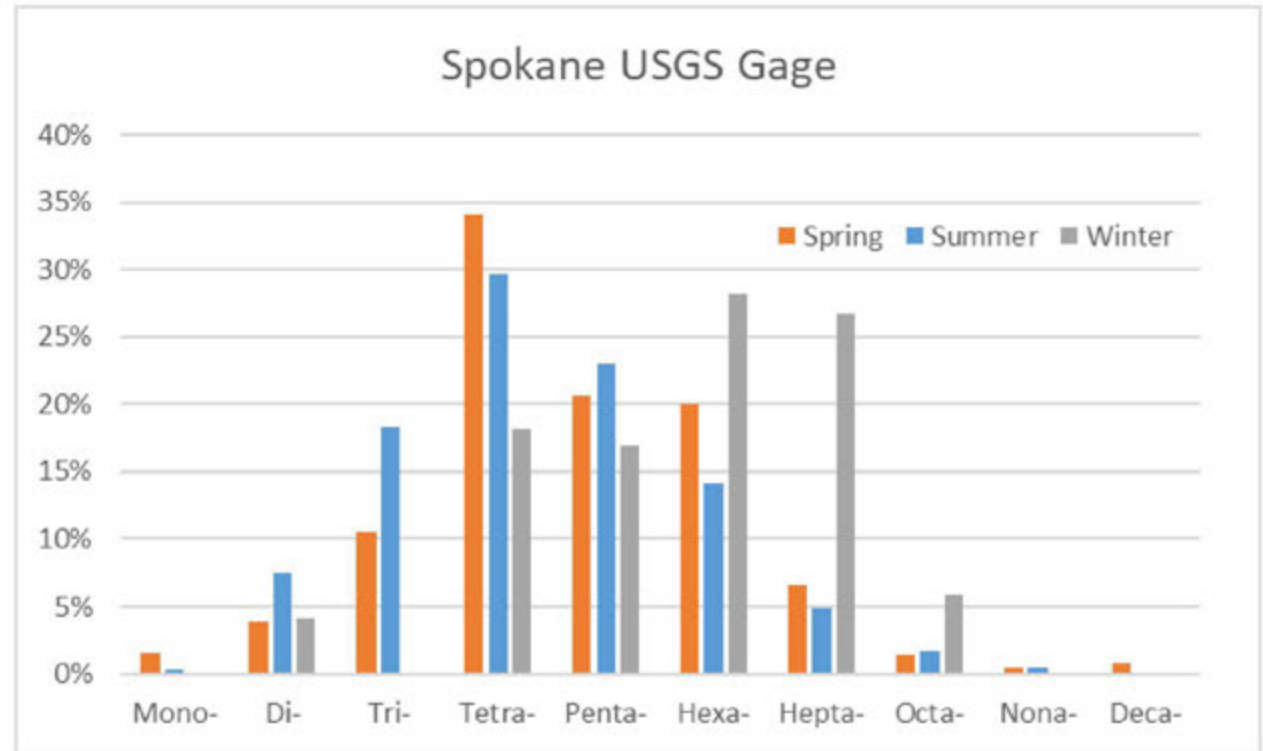
Plante's Ferry Analysis

- Very high similarity between spring and summer
 - $\text{Cos-}\theta=0.964$
- Lower similarity between winter and other seasons
 - Summer-winter $\text{Cos-}\theta=0.857$
 - Spring-winter $\text{Cos-}\theta=0.887$
 - Single winter sample



USGS Gage Analysis

- High similarity between spring and summer
 - $\text{Cos-}\theta=0.968$
- Lesser similarity between winter and other seasons
 - Summer-winter $\text{Cos-}\theta=0.71$
 - Spring-winter $\text{Cos-}\theta=0.80$
 - Single winter sample



In-River Seasonality: Conclusions

- Not seeing a marked difference in spring vs. summer homolog patterns at Plante's Ferry and USGS gage
 - No strong evidence of seasonally varying loads
- Insufficient data to say anything about winter flow
- Will additional monitoring help?
 - Yes, if we want to rigorously assess seasonality